

**Kafri, Mukamel and Peliti Reply:** In the opening statement of his Comment [1], Azbel summarizes the main results of the two papers which are the subject of his Comment by stating that "They find a first order phase transition [2] when disorder is strong (i.e. the ratio  $v$  of the binding energies is large; in DNA  $v$  is 1.1) and the Griffiths singularity, i.e. infinite order transition, otherwise [3]". In fact, the two papers claim quite the opposite. In [2] it is found that when disorder is large, the system exhibits a very weak, infinite order, Griffith type singularity at a low temperature. This is *in addition* to the melting transition which takes place at a higher temperature, and on which nothing is said in [2]. In [3] it is demonstrated that in the homogeneous case a first order melting transition takes place.

Let us briefly respond to the specific claims on each of the papers. Addressing the paper "Griffiths Singularities in Unbinding of Strongly Disordered Polymers" [2], Azbel first claims that there is no Griffiths type singularity in the *unbinding transition*. We stress that our model is not aimed at analyzing the unbinding transition, as is stated very clearly in our paper. Our model comprises of two polymers bound by either weak bonds (with an energy of  $O(1)$ ) or strong bonds (with an energy of  $O(v) \gg 1$ ). It is found that the model exhibits a Griffiths type singularity at a low temperature  $T_G = O(1)$  in addition to the melting transition which takes place at a much higher temperature  $T_M = O(v)$ . The low temperature transition corresponds to the unbinding of polymer stretches with a low binding energy of  $O(1)$ . The model is analyzed exactly in the limit where the binding energy  $v = \infty$ . Since the low temperature transition does not involve the unbinding of the strong bonds, the nature of the transition is expected to remain unchanged when the binding energy  $v$  is finite but large. The high temperature transition has recently been analyzed in [4] and [5] with conflicting conclusions.

Next, Azbel claims that the proof of the existence of Griffiths type singularity presented in [2] is invalid. This statement is not substantiated by any argument and is simply wrong. In the paper we have demonstrated that the free energy is singular at  $T_G$ , by showing that the zeros of the partition sum accumulate arbitrarily close to the real temperature axis in the thermodynamic limit. In addition it is shown that all derivatives of the free energy are finite at this temperature. The singularity is thus by definition of a Griffiths type. Azbel also erroneously state that the free energy Eq. (17) yields a *second order* phase transition while it is evident that all derivatives of the free energy are finite at the transition temperature, making the transition infinite order.

In his comment on the second paper "Why is the DNA Transition First Order?" [3], Azbel misinterprets the paper and applies its conclusions to the unbinding transition of an infinitely long heteropolymer. In our paper we analyzed the unbinding of a *homopolymer* and showed that when excluded volume effects are properly taken into account the melting transition is first order. This result may be used to understand the experimental observation that in DNA molecules which are a few thousands base pairs long the unbinding takes place by a series of steps which are sharp. Each step corresponds to the unbinding of a finite region of a few hundred base pairs long within the DNA molecule. The fact that the steps are sharp but somewhat rounded may be understood as a broadening of the first order transition resulting from the finite length of the region and the heterogeneity of the molecule. Clearly when one considers the melting of a very long DNA molecule (of the order of  $10^6$  base pairs) the steps are averaged out and the resulting melting transition is of a different nature which has to be properly analyzed. One should not use our results, obtained for the melting of a homopolymer, to analyze the melting of a very long heteropolymer, as was done by Azbel in his comments. Our results are applicable for the understanding of the sharp steps which take place in the melting curve of not too long polymers of the order of a few thousands base pairs long.

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